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# Blow out fracture recent concepts

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**Dr. T Balasubramanian M.S. D.L.O**

**Introduction:**

**Blow out fracture of orbit is defined as fracture of one or more of its internal walls. This injury is typically caused by blunt trauma to orbit. In pure terms this definition does not involve the orbital rim. If fracture of orbital rim is associated with fractures of one or more of its internal walls then the term complex blow out fracture is used. Even though there is nothing complex about it, this term is used to stress the importance of non involvement of orbital rim in blow out fracture. Blow out fracture is actually a protective mechanism which ensures that sudden build up of intraocular pressure which could be detrimental to vision does not occur following frontal injury to orbit.**

**History: Blow out fracture of orbit was first described by Lang in early 1900's. The exact description of the fracture and the terminology (blow out fracture) was first coined by Converse and Smith. It was infact Smith who first described inferior rectus entrapment in between the fractured fragments, causing decreased ocular mobility.**

**Anatomy of orbit:**
**A brief discussion of anatomy of orbit will not be out of place here. Bony orbital cavity is formed by contributions from:**

1. **Lacrimal bone**
2. **Orbital process of maxilla**
3. **Orbital process of zygoma**
4. **Orbital process of frontal bone**
5. **Ethmoid bones**

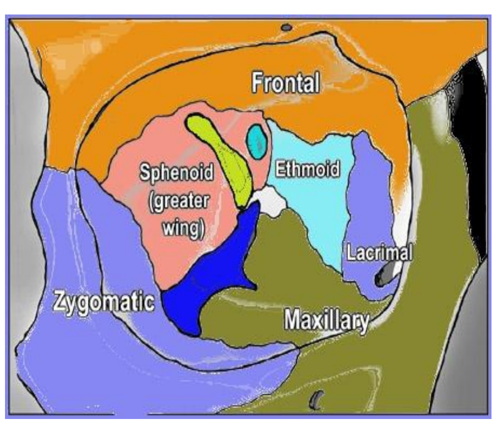


**Diagram showing anatomy of orbit**

**The medial canthal tendon attaches via a thick limb to the anterior lacrimal crest and by a thinner limb to the posterior lacrimal crest. This thinner limb contains the Horner's muscle. Similarly the lateral canthal ligament also contains two limbs. The thin anterior limb blends with the orbicularis oculi muscle and the periosteum of lateral orbital rim. The thicker posterior limb gets attached to the Whitnall's tubercle of the zygoma. The medial canthal tendon is intimately related to the lacrimal system.**

**The upper and the lower puncta begin 5 – 7 mm lateral to the medial canthus and continue as common cannaliculus into the lacrimal sac located between the anterior and posterior limbs of medial canthal tendon within the lacrimal fossa. The lacrimal sac empties its contents into the inferior meatus through the nasolacrimal duct. The lacrimal gland is located in the lateral portion of the upper lid. It is divided into a larger orbital and smaller palpebral portion by the lateral horn of levator aponeurosis. Anteriorly the gland's orbital portion is in contact with the orbital septum.**

**Extraocular muscles: Include 2 oblique and 4 rectus muscles. The superior oblique muscle due to its oblique course is in direct contact with the periorbita of the roof, and medial wall of orbit at the level of trochlea. All the 4 recti muscles arise from the annulus of zinn and gets inserted into the sclera.**

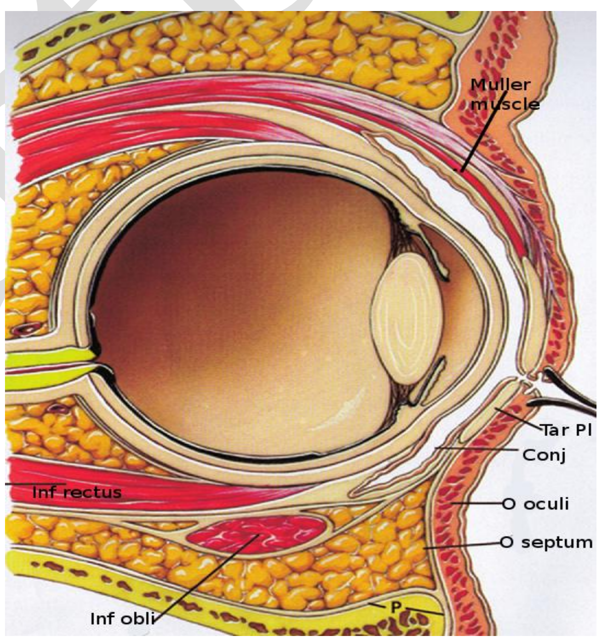



**Figure showing anatomy of orbit lateral view**

**Classification of blow out fracture:**

1. **Orbital floor blow out fracture - Commonest**
2. **Medial wall blow out fracture – This is rare even though it is lined by the paper thin lamina papyracea, because of the support it receives from the bony Ethmoidal labyrinth.**
3. **Superior wall blow out fracture – rare**
4. **Lateral wall fracture – involves zygoma**

**Signs of blow out fracture:**

1. **Periorbital ecchymosis (very commonly seen in blow out fractures)**
2. **Disturbances of ocular motility**
3. **Enophthalmos**
4. **Infraorbital nerve hypoaesthesia / anesthesia**

**Puttermann in 1974 firmly believed that no patient with blow out fracture of orbit should undergo surgical reduction before 4 -6 weeks after injury. He firmly believed that given time tissue oedema and hematoma will regress improving patient's condition.**

**Theories accounting for blow out fracture: The exact mechanism causing blow out fracture is yet to be elucidated. Two theories have been going around for quite sometime. They are:**

**1. Buckling theory**

**2. Hydraulic theory**

**Buckling theory: This theory proposed that if a force strikes at any part of the orbital rim, these forces gets transferred to the paper thin weak walls of the orbit (i.e. floor and medial wall) via rippling effect causing them to distort and eventually to fracture. This mechanism was first described by Lefort.**


Figure showing the direction of forces via the rippling effect accounting for the Buckling theory

**Hydraulic theory: This theory was proposed by Pfeiffer in 1943. This theory believes that for blow out fracture to occur the blow should be received by the eye ball and the force should be transmitted to the walls of the orbit via hydraulic effect. So according to this theory for blow out fracture to occur the eye ball should sustain direct blow pushing it into the orbit.**

**Water House in 1999 did a detailed study of these two mechanisms by applying force to the cadaveric orbit. He infact used fresh unfixed cadavers for the investigation. He described two types of fractures:**

**Type I: A small fracture confined to the floor of the orbit (actually mid medial floor) with herniation of orbital contents in to the maxillary sinus. This fracture was produced when force was applied directly to the globe (Hydraulic theory).**

**Type II: A large fracture involving the floor and medial wall with herniation of orbital contents. This type of fracture was caused by force applied to the orbital rim (Buckling theory).**

**Clinical features of blow out fracture:**

**. Intraocular pain**

**. Numbness of certain regions of face**

**. Diplopia**

**. Inability to move the eye**

**. Blindness**

**. Epistaxis**

**Patient may also show signs of:**

**. Enophthalmos – This can be measured objectively by Hess charts and Binocular single vision.**

**. Oedema**

**. Haematoma**

**. Globe displacement**

**. Restricted ocular mobility**

**. Infraorbital anesthesia**

**Proptosis in these patients is sinister because it indicates retrobulbar / peribubar hemorrhage.**

**Pupillary dysfunction associated with visual disturbances indicates injury to optic nerve and it is an emergency. Patient must be taken up for immediate optic nerve decompression to save vision.**

**A complete ophthalmic examination is a must in all these patients.**

**Indications for surgical repair:**

1. **Persistent diplopia in the primary position of gaze**
2. **Symptomatic disturbance of ocular mobility – if persisting for more than 2 weeks is considered to be an absolute indication by many. This two week window is considered because it is the time taken by edema / hematoma of orbit to resolve. Two weeks after the injury fibrosis and adhesions begin to develop. Any surgery performed before development of adhesions / fibrosis has best results.**
3. **Radiological evidence of extraocular muscle entrapment**
4. **Enophthalmos of more than 2 mm**
5. **Large fractures involving the floor of the orbit (more than 50% of the floor is involved)**
6. **Infraorbital nerve hypoaesthesia / anesthesia**

7. **Presence of oculo cardiac reflex (common in trap door type of fracture). Surgical repair should be performed immediately in these patients.**

**Surgical repair should be delayed:**

1. **When there is presence of hyphema**
2. **Ocular rupture**
3. **Extensive oedema**

**Causes of ocular motility disturbances:**

1. **Intraorbital tissue hemorrhage – usually resolves during the first week of injury**
2. **Intraorbital tissue oedema – resolves during the second week of injury**
3. **Entrapment of extraocular muscles**
4. **Entrapment of orbital fat**
5. **Direct damage to extraocular muscles – causes adhesions and scarring within two weeks of injury. This stage should be considered to be point of no return as surgical results are poor.**
6. **Direct damage to nerve supply of extraocular muscles**
7. **Direct damage to blood supply of extraocular muscles**

**Blow out fracture involving orbital floor:**

**This is the commonest type of blow out fracture encountered. The floor of the orbit is divided in to medial and lateral segments by the Infraorbital nerve. The segment of the floor medial to the nerve is larger and more fragile, hence is commonly involved in blow out fractures.**

**Boundaries of medial segment of orbital floor:**

1. **Inferior orbital fissure – posteriorly**
2. **Bony canal of Infraorbital nerve – laterally**
3. **Orbital rim – anteriorly**
4. **Inferior aspect of lamina papyracea (Laminar bar) – medially**

**Lateral segment of the floor of orbit:**

**This segment is smaller, thicker and stronger than the medial segment of orbital floor. Fractures involving this segment are pretty rare.**

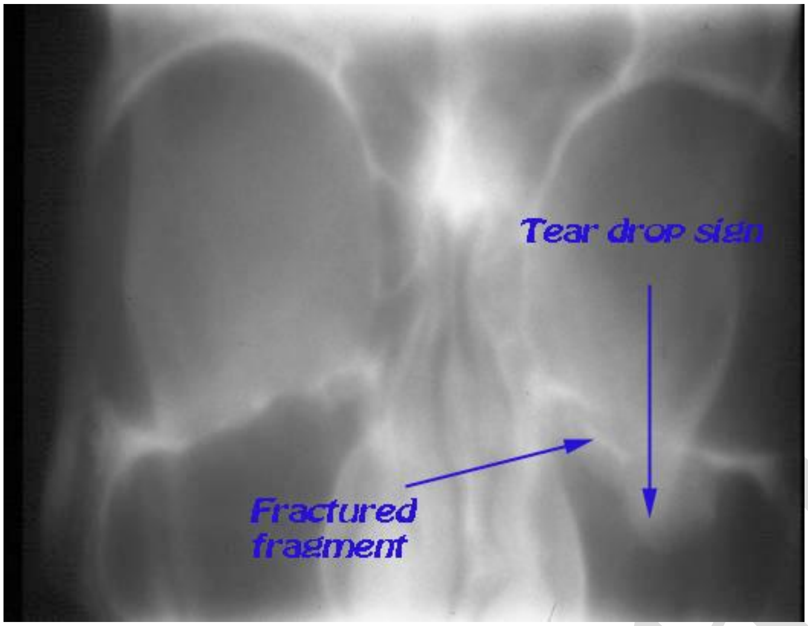

**Clinical photograph of a patient with blow out fracture**

**Classification of orbital floor fractures:**

**According to fracture patterns, fractures involving orbital floor may be classified into three types. This classification helps in deciding the optimal management modality.**

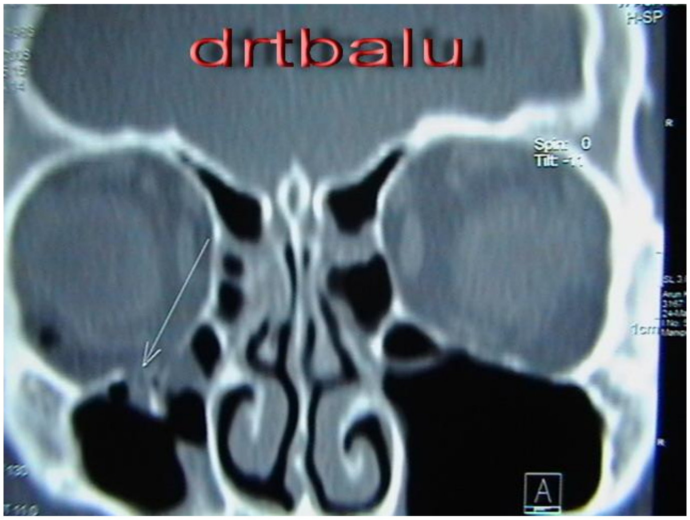
1. **Trap door type – This type of fracture occurs when a large fragment of the medial floor of the orbit is fractured and remains still attached to the laminar bar medially. This fracture resembles a trap door hinged at the laminar bar (lamina papyracea).**
2. **Medial blow out – This type of fracture occurs when there is bone disruption between the laminar bar and the Infraorbital nerve.**
3. **Lateral blow out – This type of fracture causes a comminution from the laminar bar to the lateral orbital wall.**

**Imaging:**




**X -ray paranasal sinuses: May show the classical "tear drop sign" of prolapsed orbital contents. The fractured fragment may also be visible. The corresponding maxillary sinus may appear hazy due to the presence of hemosinus.**

**CT scan is diagnostic:**




**CT (coronal) showing blow out fracture**

**Blow out fracture involving the medial wall of orbit:**
**Fractures involving medial wall of orbit may occur alone or as part of more complex orbital fractures. Pure medial wall fractures are really rare. Fractures involving medial orbital wall may be missed in plain radiographs, hence CT scan is diagnostic.**

**Clinical features of fracture medial wall:**

1. **Periorbital oedema**
2. **Ecchymosis**
3. **Subcutaneous emphysema due to escape of air from ethmoid sinus in the periorbital space**
4. **Epistaxis**
5. **Enophthalmos – According to Pearl enophthalmos is worse in medial blow out fractures than fractures involving other walls of orbit.**

**Classification of medial wall of orbit:**

**Type I – Pure medial wall of orbit fracture**

**Type II – Medial wall and floor of orbit fracture**

**Type III – Fractures involving medial wall, floor of orbit and trimalar fracture**

**Type IV – Fractures involving medial wall, floor of orbit, maxillary, naso orbital, and frontal bones**

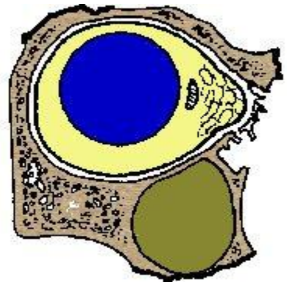


**Figure showing type I fracture of medial orbital wall**

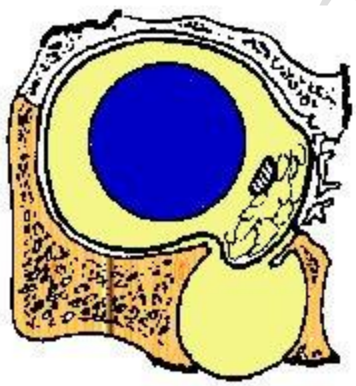


**Figure showing type II fracture of medial orbital wall**

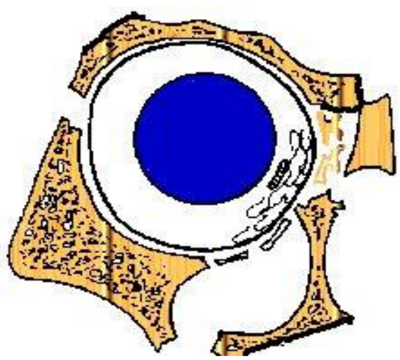


**Figure showing type III fracture of medial orbital wall**

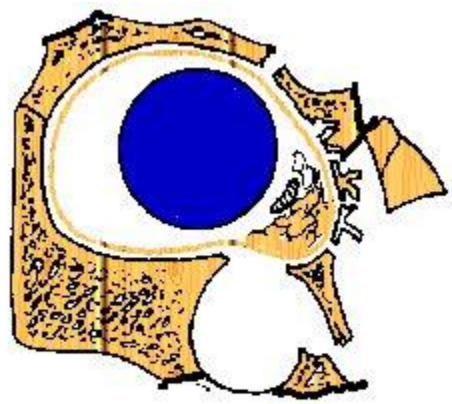


**Figure showing type IV   fracture of medial orbital wall**

**These classification systems are based on CT scan findings.  Type I medial orbital wall fractures are commonly caused by assault, while other types of fractures are caused by road traffic accidents.**
**Visual disturbances were commonly seen in type I, II, and III fractures involving the medial wall of orbit, and is very rare in type IV fractures.**
**Eye ball injuries are common in type II fractures of medial wall.**
**Diplopia and enophthalmos are commonly seen in type II fractures.**
**Displacement of orbital walls and herniation of soft tissues were quite high for type I, type II and type IV injuries.  It is very uncommon in type III injuries, suggesting that when there is associated malar fracture then the fragments are more linear without any displacement.**
**Type I fractures can be repaired using fronto ethmoidal lesion / Lynch Howarth and reduction of prolapsed orbital contents and supporting the wall using Marlex mesh, whereas other types of fractures involving medial orbital wall can be repaired by subciliary / transconjuctival approaches.**

**Fractures involving lateral orbital wall:**

**Fractures of lateral orbital wall is always associated with fractures of zygoma and malar complexes.  This fracture is common in adults and is very rare in children.  This fracture should be suspected in all patients who have severe facial injury.  Imaging is a must not only for diagnosis but also to decide the optimal management modality.**

**A brief review of anatomy of lateral orbital wall wont be out of place here.  The lateral orbital wall is formed by the zygomatic bone anteriorly.  This bone is**

**responsible for mid face prominence. The posterior wing of sphenoid forms the posterior portion of the lateral orbital wall along with the anterior corner of the middle cranial fossa. Fractures involving the greater wing of sphenoid is very rare. Articulation between the zygomatic bone and greater wing of sphenoid is very broad and is the commonest site in fractures involving lateral orbital wall. Fractures involving lateral wall of orbit is also associated with disruption of zygomatic bone articulations with frontal, temporal and maxillary bones.**

**Clinical features:**

1. **These patients have varying degrees of mid face deformities**
2. **Displacement of lateral orbital wall has a dramatic effect on the position of the eye. The lateral orbital rim is approximately at the equator of the globe. Infro lateral displacement of the lateral orbital wall will have significant change in the postion of the orbit when compared to that of simple infraorbital floor blowout fracture.**
3. **Visual loss may occur due to injury to the optic nerve. Whenever there is visual loss then retrobulbar hemorrhage, penetrating foreign body or bony fragment impinging on the optic nerve should be considered.**
4. **Lateral canthal dystopia**
5. **Ecchymosis**
6. **Subconjunctival hemorrhage**

**Axial and coronal CT scans should be taken in all these individuals.**

**Management:**

**Repair of open globe injuries takes precedence over fracture reduction. In patients with globe injuries fracture reduction can always be delayed. If intraocular pressure is found to be very high, bedside lateral canthotomy / cantholysis should be performed immediately to reduce the tension. If done immediately this procedure will save vision in a majority of these patients.**
**If the orbit appears tense and tight surgical evacuation of orbital hematoma should be resorted to.**

**Specific management of these fractures are dependent on the following factors:**

1. **Degree of displacement of fractured fragments**
2. **Comminution of fracture**
3. **Intracranial extension of sphenoid fracture**

**Non displaced / mildly displaced fractures can be managed conservatively. If fracture causes displacement with visual loss / ocular motility disturbance, enophthalmos, flattening of malar eminence fracture repair is indicated. Before actually embarking on surgical repair preexisting corneal incision wounds need to be evaluated for possible leak during surgery. Although there may not be significant elevation of intra ocular pressure aqueous fluid may leak through**

**preexistent corneal wounds causing collapse of the globe. It always pays to repair corneal wounds if any before the actual reduction procedure.**
**Before surgery a forced duction test should always be performed to rule out intraocular muscle entrapment.**

**Lateral upper eyelid crease incision can be used to expose zygomaticofrontal suture line. Infraorbital rim can be exposed via transconjuctival / subciliary incisions. Zygomaticomaxillary buttress can be accessed via buccogingival incision. To reduce comminuted fractures of zygoma a temporal / coronal incision may be used. Use of resorbable plates and screws is advisable in young children who have actively growing bones.**

**For non comminuted fractures of zygoma a two point fixation with titanium miniplate is advisable. The first point is ideally in the infra orbital rim and the second point over the frontozygomatic suture line is desirable.**

**Orbital roof fractures:**

**Orbital roof fractures always occur together with that of frontal roof fractures. It can cause diplopia due to intraocular muscle entrapment. These patients may also present with enophthalmos / exopthalmos. The commonest cause of diplopia in these patients is the entrapment of connective tissue around superior rectus within the fractured bony fragments. It is just sufficient if this entrapped tissue could be freed by endoscopically removing the fractured bony fragments.**

**Surgical approach to orbit:**

**Orbital cavity can be accessed by various surgical approaches. These approaches can be classified according to the area of orbit that becomes accessible.**

1. **Approaches to lateral wall and orbital roof**
2. **Approaches to medial wall of orbit**
3. **Approaches to the floor of the orbit**

**Approaches to lateral wall and orbital roof include:**

**a. Lateral brow incision**
**b. Upper blepharoplasty incision**
**c. Coronal incision**
**Lateral brow incision: Is suited for exposing frontal and zygomatico sphenoid sutures. The lateral portion of the superior orbital rim is also exposed well by this incision. The brow incision is placed just below the hair follicles of lateral 2-3 cm of the upper eyebrow.**

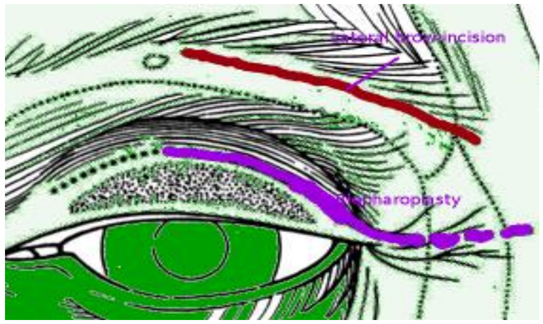


**Figure showing lateral brow incision and blepharoplasty incision**

**Before placing the incision lateral brow approach xylocaine is infiltrated inferior and parallel to the lateral border of the upper eyebrow. Incision is made just below the upper eyebrow with 15 blade. The incision is deepened and carried through skin and orbicularis oculi. The periosteum over lateral orbital rim is sharply dissected and elevated using a Freer's elevator.**

**Major disadvantage of this approach is the scarring which takes place. That is the reason why upper blepharoplasty approach became popular.**

**Upper blepharoplasty:**
**First the supratarsal fold is marked. It is typically 8-9 mm above the ciliary line. Xylocaine with adrenaline is injected subcutaneously, down to the lateral orbital rim at the zygomaticofrontal suture. Skin is incised, and the underlying orbicularis oculi muscle should be divided parallel to its fibers. This is ideally done using scissors. Dissection is then performed in a plane superficial to the orbital septum and lacrimal gland, until the lateral orbital rim and zygomaticofrontal suture as needed. The advantage of this approach is the cosmetically acceptable scar.**

**Coronal approach:**

**This approach provides excellent access to medial, superior and lateral walls of orbit, as well as the zygomatic arch. It gives excellent access to both orbits and dorsum of the nose.**
**The coronal incision begins at the upper attachment of helix and extends transversely over the skull vault to the opposite side. The incision slightly curves forwards over the vertex of the skull just behind the hair line. This incision can also be extended to the preauricular area to expose the zygoma and zygomatic arch. The line of incision should be marked previously and infiltrated with xylocaine mixed with 1 in 100,000 units adrenaline. The flap is raised leaving the periosteum intact. Raney clips (liga clips) are applied to the edges of the flap to secure hemostasis. The periosteum is incised about 3 cm above the supraorbital ridges, and the dissection should be continued in the subperiosteal plane. Care should be taken to release the supra orbital neuro vascular bundles from the notch / foramen. This subperiosteal dissection is continued inferiorly till naso ethmoidal and naso frontal**

**sutures are exposed. Laterally the dissection follows the outer layer of temporalis fascia till about 2 cms above the zygomatic arch. At the level of the arch of zygoma the temporalis fascia splits to enclose temporalis muscle. At this point an incision which runs antero superiorly at 45 degrees is made over the superficial layer of temporalis fascia. This is done to spare the frontal branches of facial nerve. This incision is connected anteriorly with the lateral or posterior limb of the supraorbital periosteal incision.**

**The plane of dissection deep to the superficial layer of temporalis fascia is carried inferiorly till the zygomatic arch is reached. The periosteum in this area is incised and reflected over the zygomatic arch, zygoma, and lateral wall of orbit. After satisfactorily reducing the fracture the wound is closed in layers.**

**Disadvantages of this approach:**

1. **Extensive incision**
2. **Alopecia**
3. **Numbness of forehead area**
4. **Injury to temporal branch of facial nerve**

**Surgical approaches to orbital floor have been classified into:**

1. **Transorbital – Transcutaneous, Transconjunctival and subciliary approaches**
2. **Transantral – includes endoscopic approach**
3. **Combined approach**

**Transcutaneous orbital rim incision is usually given just below the lower eyelid. This approach is very simple one and easy to perform. The incision area is marked and infiltrated with xylocaine mixed with 1 in 100,000 units adrenaline. Ideally the incision should hug the infra orbital rim. Orbicularis oculi muscle should be slit along its long axis. Orbital contents are retracted to expose the floor of orbit. This approach gives rise to post operative oedema. This incision also causes visible scar just below the lower eyelid.**

**Picture showing transcutaneous incision for orbital floor exposure**

**Subciliary / Subtarsal approaches to orbital floor:**

Converse originally described this incision as an approach to orbit in 1944. He was also instrumental in devising a variant of this incision i.e. subtarsal approach. Both of these incisions are types of transcutaneous incision. For this incision local anesthesia mixed with adrenaline is infiltrated subcutaneously into the lower eyelid along the infra orbital rim. A lateral temporary tarsorhaphy is performed to protect the orbital contents during the procedure. A subciliary cutaneous incision is made 2mm below and parallel to the eyelash line. This incision is usually performed using a 15 blade. Medially this incision should fall short of the punctum, while laterally it can be extended even up to 15 mm beyond the lateral canthus. The lateral extension of this incision is preferred should be extended horizontally and not inferiorly in order to promote formation of aesthetically acceptable scar. Dissection proceeds in the subcutaneous plane superficial to orbicularis oculi muscle. At the level of lower end of tarsal plate orbicularis oculi muscle is divided parallel to the direction of muscle fibers. Orbicularis oculi muscle over the tarsal plate should be protected to maintain lower lid structure and support. The dissection now follows the preseptal plane down to the level of orbital rim. The periosteum is incised over the anterior portion of infraorbital rim. This elevation of the periosteum proceeds up to the level of orbital floor.

In subtarsal variation of this procedure the incision is sited in the subtarsal fold about 5-7 mm below the eyelash line. After repair a Frost suture is applied to support the lower eyelid.

**Advantages of this approach:**

1. Easy to perform

2. Gives broad access to the floor of orbit

**Disadvantages include:**

1. **Lower lid malposition**
2. **Scarring of lower eyelid**

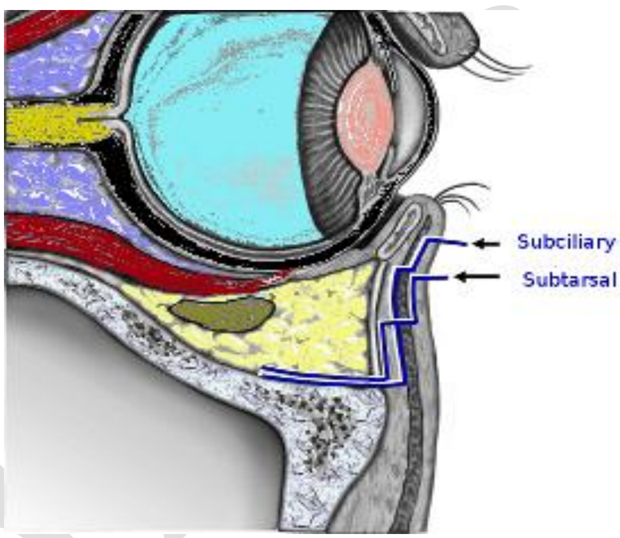



**Figure showing subciliary and subtarsal approaches**

**Transconjunctival approach to orbit: This method was popularized by Tessier. Converse etal reported treating a series of patients with blow out fracture involving the floor of the orbit using this incision. This is the most preferred approach for orbital surgeries because of low complication rates and excellent cosmesis. In this method the lower eye lid is pulled forward. To increase the laxity a lateral canthotomy should be performed.**

**Lateral canthotomy: is performed by incising the skin, subcutaneous tissue and orbicularis oculi muscle horizontally. The incision should ideally be sited in the skin crease of the outer canthal region. The lateral canthal tendon is visualized and its inferior limb alone is severed.**

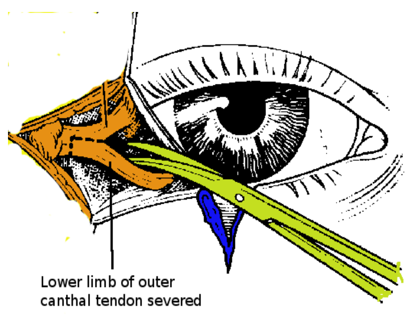



**Figure showing canthotomy being performed**

**Two methods can be performed via this incision. 1. Preseptal method and 2. Retroseptal method.**

**Preseptal method: In this method incision is made at the edge of the tarsal plate to create a space in front of the orbital plate to reach the orbital rim. The floor of the orbit is reached by dissecting the Muller's muscle and the eyelid fascia. Dissection then proceeds between orbital septum and orbicularis oculi muscle. The periosteum lining the infraorbital rim should be excised and dissected to expose completely the floor and lateral wall of the orbit if necessary.**

**Retroseptal method: In this method an incision is sited 2mm below the tarsal plate to reach the orbital rim.**

**Either of the above methods grants access to the floor of the orbit. Mild retraction is applied to the globe to visualize the floor of orbit fully. Prolapsed orbital contents can be pushed back into orbit and the defect can be closed using appropriate prosthesis.**

The major advantage of this procedure is there is virtually very minimal scar formation. It is very quick to perform and involves no skin, muscle dissection. Dissection in the plane of orbital septum is avoided, hence there is very minimal chances of vertical shortening of lower eyelid. The only disadvantage is the limitation of access to the medial portion of the orbital floor.

In cases of blow out fractures involving the medial portion of the floor of the orbit Caldwel luc procedure can be performed to reduce the fracture fragment. Nasal endoscope can be introduced through the caldwel luc fenestra to improve visualisation.

The prolapsed orbital contents are freed and reduced. Fractured fragments repositioned if possible and stabilized using plate and screws. If defect is large prosthesis can be utilized to stabilize the orbital floor.

Figure showing transconjunctival incision marked out

Complications of transconjunctival approach to orbital floor:

1. Eye lid avulsion
2. Button holing of lower eyelid
3. Canthal dehiscence
4. Cicatricial ectropion
5. Entropion
6. Lower eyelid retraction
7. Scleral show
8. Hematoma
9. Prolonged chemosis
10. Lacrimal sac laceration

Factors that can cause problems with transconjunctival approach:

1. Approach to the medial wall of orbit
2. Proptosis / orbital swelling
3. Severe chemosis
4. Severe swelling of lower eyelids
5. Laceration / trauma to conjunctiva

**Protection of cornea is another vital aspect in avoiding complications in transconjunctival approaches. This can be achieved by:**

1. **Placing plastic corneal shield**
2. **Use of Jaeger retractor which protects the cornea while retracting the orbit**

**Placement of incision – This is also vital in avoiding complications.**
**The incision should ideally be placed between the lower border of tarsus and the fornix. This incision avoids injury to the tarsal plate and also prevents scarring of the orbital septum. Efforts should be taken to prevent undue tissue damage in this area as scarring in this area will lead to a lot of problems later. Majority of the complications of this procedure is caused by scarring that occurs in this area due to excessive tissue damage. Unipolar cautery when used to make conjunctival incision should be used in the lowest possible setting. Laceration and conjunctival tears should be avoided.**

**While performing lateral canthotomy lysis of the superior crus of lateral canthus should be avoided. Only the inferior crus should be lysed. Moreover while performing lateral canthotomy excessive incisions of conjunctiva should be avoided. It has been shown proper canthotomy avoids excessive traction of lower eyelid during surgery, thus prevents lid lacerations.**

**Technical aspects of conjunctival closure:**

**Granulations have been found to occur when there is improper healing of conjunctival suture line. This eventually leads to scarring of fornix. To avoid this complication limited closure of conjunctiva has been resorted to. Only two sutures are given using 6 – 0 catgut on either side of limbus. Any extra sutures given always leads to problems of granulation in the area.**

**Resuspension of inferior canthal tendon:**

**This is another important step in transconjuctival procedures where lateral canthotomy has been resorted to. If not performed properly canthal migration has been known to occur in the inferior direction. It is always better to use permanent suture materials like Teflon impregnated braided polyester suture material to suspend the inferior canthal tendon. In case extensive dissection was performed to expose the lateral wall of orbit by stripping orbital periosteum in that area, the inferior canthal tendon should be secured to the lateral bony wall of orbit by using 30 gauge wire. This will prevent canthal migration in these patients. If both superior and inferior crura of lateral canthal tendon were excised during surgery then reconstruction gets a bit complicated. In these patients the inferior crus must be reattached to the lateral orbital wall just posterior and superior to Whitnall's tubercle. This is usually done by using 30 gauge wires. Then only should the superior crura should be reattached.**

**Reconstruction of lateral canthal angle:**

**This is another aspect of repair that should be taken note of. After securing the inferior crura of lateral canthal ligament reconstruction of lateral canthal angle must be resorted to. This is usually performed using absorbable sutures taking care to line up the anatomic eyelid markers.**

**Resuspension of orbicularis muscle:**

**This is the next step that should be carefully performed. The orbicularis muscle which was elevated off the lateral orbital periosteum should be resuspended carefully using 4-0 absorbable sutures. Usually it is resuspended in an over corrected position. This is done to allow for change in position due to fibrosis.**

**Frost stitch:**

**This stitch is usually used to splint the lower eyelid during the period of repair. This is usually a must in patients with excessive chemosis / proptosis. This stitch is usually placed through the lower eyelid and suspended from the forehead with the help of a tape atleast for a period of three days following surgery. This provides excellent splinting to the lower eye lid during this crucial phase of healing.**

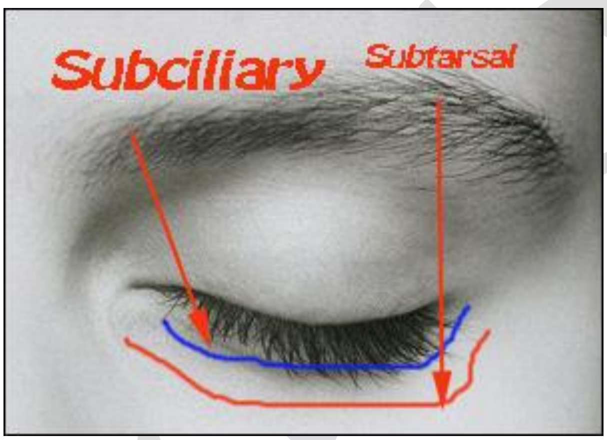



**Figure showing subciliary and subtarsal incisions marked**

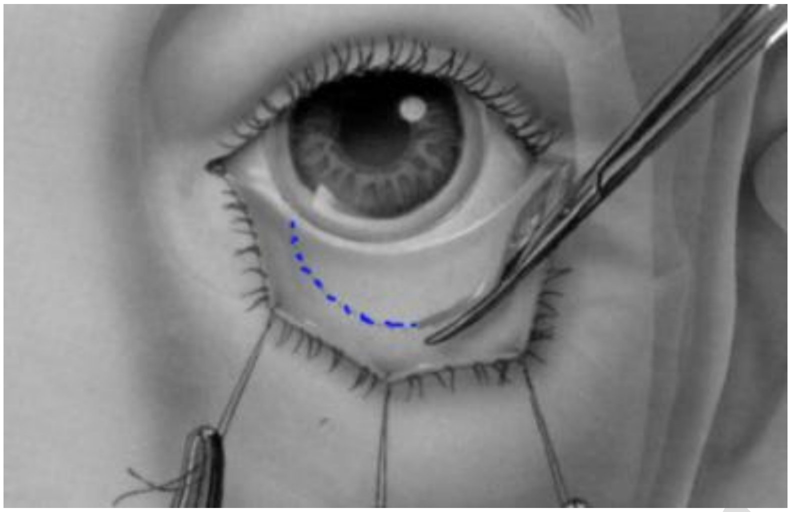


**Figure showing incision for Transconjunctival approach**

**Endoscopic reduction / repair of blow out fracture:**
**Indications:**

**They are more or less identical to that of traditional repair procedures. Indications include:**

1. **Isolated fractures involving the floor of the orbit with extraocular muscle entrapment.**
2. **Preoperative Enophthalmos**
3. **More than 50% disruption of orbital floor**
4. **Trap door and medial blow out fractures of floor of orbit respond the best to Endoscopic repair**

**In lateral blow out fractures of orbital floor Endoscopic repair will jeopardize the Infraorbital nerve as extensive dissection is necessary in that area.**

**Procedure:**

**Primary surgeon if he is right handed should stand to the right of the patient. The table is usually turned 180 degrees from anesthesia equipment. The assistant surgeon and the nurse should be on the left side of the patient. Monitor should be placed at the head end of the patient. Both the surgeon and his assistant should have an unobstructed view of the monitor.**

**Incision:**

The upper buccal sulcus on the side of injury is infiltrated with 2% xylocaine mixed with 1 in 100,000 units adrenaline. This infiltration helps in elevation of soft tissue and periosteum from the anterior portion of the maxilla. It also has the added advantage of minimizing bleeding. A 4 cm sub labial Caldwell incision is given in that area exposing the anterior wall of the maxilla. Dissection is performed in a subperiosteal plane up to the level of Infraorbital foramen. Excessive traction should not be exerted in the Infraorbital nerve area.
A 4 mm antrostomy is performed over the canine fossa are. This is the thinnest portion of the anterior wall of the maxilla. Boundaries of canine fossa include:

1. Canine eminence medially
2. Maxillary tuberosity laterally
3. Infraorbital foramen superiorly
4. Superior alveolar margin inferiorly

The antrostomy is widened using kerrison's rounger. Final dimensions of antrostomy should at least be 1 x 2cms and should lie about 2mm below the Infraorbital foramen. When enlarging the antrostomy care must be taken not to injure dental roots, Infraorbital nerve and the nasal aperture. As an alternative a bone saw can be used to remove a 1 x 2 cms plate of bone from the canine fossa area and can always be plated back in position after surgery is over. This procedure is considered more anatomical as the area of surgery is reconstructed.

A retractor is used to retract the upper lip. Ideally a Greenberg retractor is best suited for the procedure because of its self retaining nature. If not available a Langhan's retractor can also be used. Caution should be exercised while retracting the upper lip in not causing excessive traction to the Infraorbital nerve.

A 30 degree endoscope is introduced through the antrostomy with the angulation facing upwards. The entire floor of the orbit can be studied. If necessary the maxillary sinus can be irrigated with saline via the irrigation sheath of the endoscope and sucked out clearing blood clots and other debris from the maxillary sinus cavity. This step will help in better visualization of the area of interest. The natural ostium of maxillary sinus can be located in the postero superior portion of the medial wall of the sinus. The infra orbital nerve could be seen as a while line running from the orbital apex to the Infraorbital foramen. It is imperative on the part of the surgeon to identify the maxillary sinus ostium and infra orbital nerve before proceeding further, in order to avoid injury to these structures.

Pulse test: This test is usually performed after completely visualizing the floor of orbit as well as the above mentioned vital intra sinus structures. This test is performed while the floor of the orbit is fully under Endoscopic view. Pressure is applied to eye ball causing mild displacement of the fractured floor of orbit. This can be visualized endoscopically to assess the dimensions of fracture as well as the extent of prolapse of orbital contents.

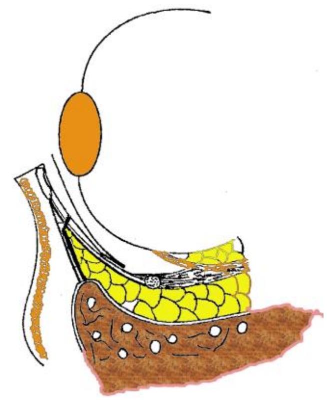


**Figure showing plane of dissection in retroseptal transconjunctival incision**

**Endoscopic repair of trap door fracture:**

**In trap door fracture of orbital floor there is mild – moderate degree of orbital fat herniation. Strangulation of herniated orbital contents are common in these patients. This area appears endoscopically as enlarged and tense area. These fractures can be managed by reduction and repositioning of the fractured and displaced fragments. No prosthesis is necessary. As a first step in reduction of these fractures an angled elevator is used to expose 5 – 7 mm of maxillary sinus bone close to the lateral edge of the defect. Care is taken not to disrupt the mucosa over the hinge area as it would cause complete disruption of the fractured fragment. The lateral edge of the bone flap is retracted inferiorly; the orbital fat will immediately prolapse into the maxillary sinus. This fat tissue would have been entrapped within the fractured fragments of bone. A periosteal elevator is used to gently reduce the prolapsed orbital contents into the orbital cavity. The bone flap is hinged back into position. Care should be taken to ensure that this flap doesn't entrap orbital fat / Infraorbital nerve. Interfragmentary resistance maintains the reduction in place. If there is fragmentation of the lateral edge of the bony flap then Interfragmentary resistance may not be sufficient to maintain the bone flap in position. Then this procedure cannot be used and other methods of stabilization of fracture should be resorted to.**

**Keys to Endoscopic repair of trap door fracture include:**

1. **Meticulous dissection of lateral fracture margins**
2. **Minimal dissection over laminar bar, thus maintaining stability of the hinge region**
3. **Complete reduction of orbital contents**

**Endoscopic repair of medial blow out fracture: These fractures pose real challenges during Endoscopic reduction. These fractures are usually comminuted and unstable, hence requires more dissection and an implant for reconstruction of orbital floor. About 5 – 7mm of maxillary sinus mucosa should be dissected around the fracture taking care to protect the maxillary sinus ostium and the Infraorbital nerve. The entire circumference of the fracture should be visualized. Bleeding if any should be controlled using either oxymetazoline pledgets or adrenaline pledgets. All fractured fragments should be separated from the periorbita and removed. After defining the margins of fracture 3 – 5 mm dissection of the orbital surface of the defect is performed. This step releases the periorbita around the defect to accommodate the implant. After this step a greater degree of prolapse of orbital contents into the maxillary sinus cavity could be seen. This may seem to be worse than the pre op condition, but is to be expected. Silastic sheet of approximate size is introduced. The implant is resized and shaped according to the size of the defect by trial and error. It should be roughly 1.5 – 2 mm larger than the size of the defect. Orbital contents are gently reduced using a periosteal elevator and the implant is inserted. The implant is usually held in position by the orbital rim and the posterior bony shelf. The implant should ideally be positioned between the medial and lateral shelves. A pulse test should be performed to ensure that the implant is firmly in place. A forced duction test should also be performed to rule out orbital content entrapment.**

**Key points that must be borne in mind while managing Medial blow out fracture endoscopically:**

1. **The entire circumference of the defect should be visualized**
2. **All the fractured bone fragments should be removed because while inserting a prosthesis some of them may be pushed into the orbital cavity**
3. **Complete dissection and visualization of posterior shelf is critical**
4. **Medial fracture margin is difficult to define because it is oriented vertically, hence aggressive dissection in this area should be avoided.**
5. **The implant can be maintained in position by the anterior, posterior and lateral shelves**

**Postoperatively all patients should undergo CT scan to ensure that no orbital fat / contents are entrapped, and no bony fragments have been pushed into the orbit during placement of implant.**

**Patients with zygomatico - maxillary complex fractures also have orbital component injury. It should be borne in mind that there is a possibility of orbital floor fracture worsening after reduction procedures involving the zygoma component. All these patients must undergo Endoscopic examination of the orbital floor bearing in mind of this possibility. If there is also associated fracture of orbital floor then it should bee managed endoscopically.**

**Combined Transconjunctival – Endonasal – Transantral approach:**

This approach is finding prominence in ophthalmology literature. Important drawback of this procedure is extensive removal of lateral nasal wall to facilitate Endoscopic visualization. With the introduction of 70 degree endoscopes removal of lateral wall can be minimized.

**Procedure:**

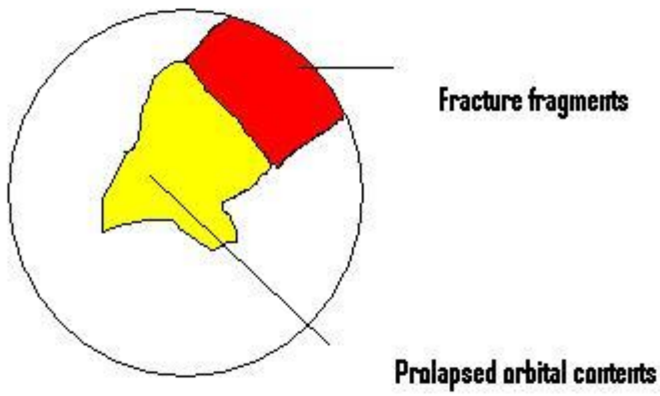
Patient is placed supine with head in a slightly elevated position. The nasal cavity is packed with 4% xylocaine and 1 in 10000 adrenaline. This helps in decongesting the nasal mucosa as well as reducing bleeding during surgery. Under Endoscopic guidance the lateral nasal wall is infiltrated with 2% xylocaine with 1 in 100,000 units adrenaline. The following structures should be removed:

1. Uncinate process
2. Ethmoidal bulla
3. Basal lamella

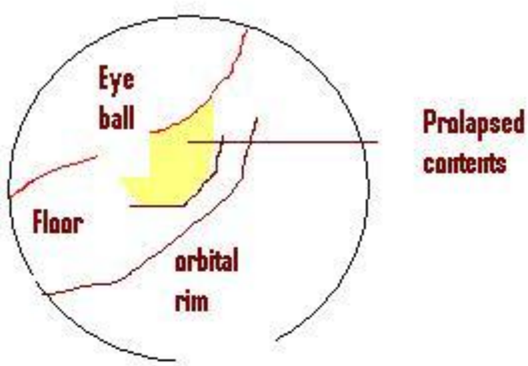
After removing these structures a partial posterior ethmoidectomy should be performed. The condition of medial orbital wall is examined. A gentle push to the eye ball can be seen as bulging of medial orbital wall through the nasal cavity. Similarly a gentle tug to the medial rectus muscle will help in identification of entrapment of medial rectus muscle within the fracture fragments (this is called forced duction test). If the orbital contents are found to be prolapsed through the defect in the medial wall of orbit, then it must be gently reduced. If forced duction test is positive then the entrapped extraocular muscle (medial rectus in this case) should be freed under Endoscopic vision.

The Natural ostium of maxillary sinus is enlarged both in the anterior and posterior directions. This is done in order to visualize the floor of the orbit through the maxillary antrum. A 70 degree 4mm nasal endoscope is used to visualize the interior of the maxillary sinus cavity. In case there is prolapsed orbital tissue / Infraorbital nerve then an incision is made in the palpebral conjunctiva just below the tarsal plate. Dissection can be pursued in the preseptal plane to reach the inferior border of the orbit. At the level of Infraorbital rim the periosteum should be incised to gain access to the floor of the orbit. On reaching the orbital floor the prolapsed tissue is reduced back into the orbit by dual approach (above and below via the maxillary antrum). Reduction via the maxillary antrum is performed under Endoscopic guidance. Orbital floor should be reconstructed if the defect is more than 2 cm. If there is Enophthalmos then medial wall of the orbit should also be reconstructed. Thin autologous iliac bone grafts are best suited for this purpose. The tissues can be held in position by inflated bulb of Foley's catheter placed inside the maxillary antrum and nasal packing. Merocel is the preferred nasal pack as it can be left in situ for more than 2 weeks without any fear of complications.

**Caution: This approach is not suitable for small children with tooth buds in the anterior wall of the maxillary antrum.**




**Diagrammatic representation of Endoscopic view of fractured orbital floor via the maxillary antrum**




**Fracture of orbital floor as seen via Transconjunctival approach**

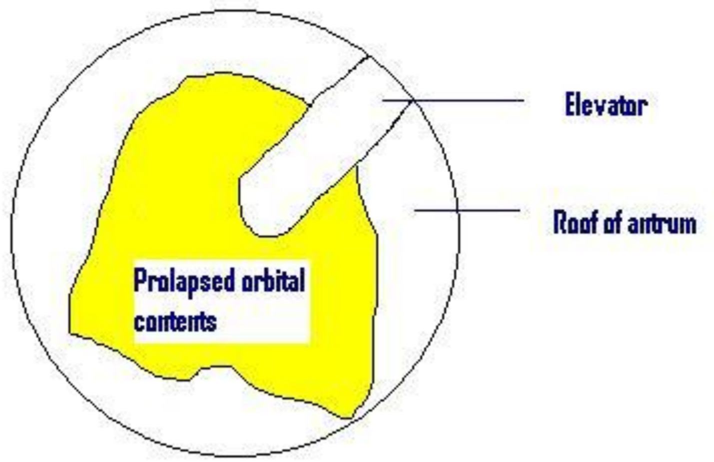



**Figure showing orbital contents being reduced under Endoscopic guidance via maxillary antrum**

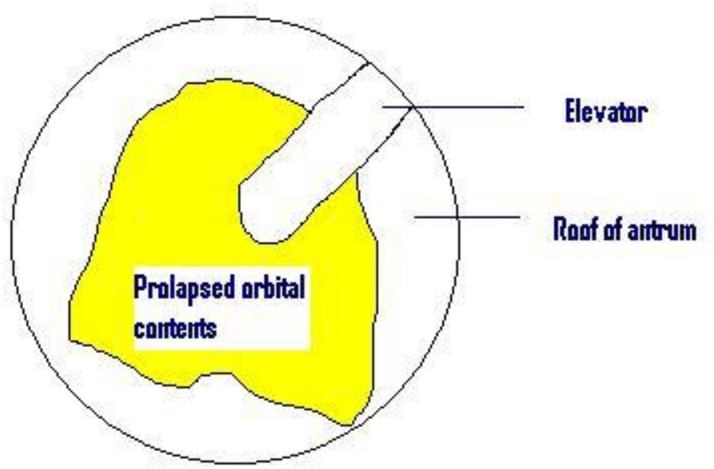



**Image showing post reduction scenario as visualized via maxillary antrum with the help of nasal endoscope.**

**Materials used for reconstruction of orbit:**

1. **Teflon sheets**
2. **Titanium meshes**
3. **Iliac bone crests**
4. **Septal cartilage**
5. **Biomaterials made from polylactide polymers**

**Preference of graft material depends on the surgeon's choice and his experience with using such prosthesis.**

**However ideal reconstruction material should have the following features:**

1. **Material should be thin, strong and light on weight**
2. **It should be easily cut and shaped**
3. **Once molded it should retain its shape**
4. **It should be radio opaque facilitating further radiological studies**

**Implant related complications include:**

1. **Infection and extrusion of implants**
2. **Displacement / migration of implants causing ectropion and diplopia**
3. **Lacrimal obstruction and epiphora**
4. **Capsular contracture over implants leading to pain**
5. **Presence of implant may lead to chronic smoldering inflammation delaying the process of normal healing**

**Advantages of titanium meshes as an implant material:**

1. **It is easy to trim and mould according to the dimensions of orbit. This feature is very pertinent when dealing with combined blow out fractures involving the floor and medial wall of orbit.**
2. **Its mesh like structure enables tissue to grow around it as well as through the pores. This affords a stabilizing effect to the graft material preventing its migration**
3. **It has excellent tensile strength even when cut to thin sizes. Hence can be safely used to bridge large defects of orbital floor**
4. **It can be sterilized by conventional means**
5. **It produces less artifacts in CT images**

**Draw backs of titanium mesh:**

1. **It is very difficult to remove in cases of infection as the tissue would have grown around and through the pores of the mesh.**
2. **It can migrate posteriorly towards the orbital apex causing further complications**

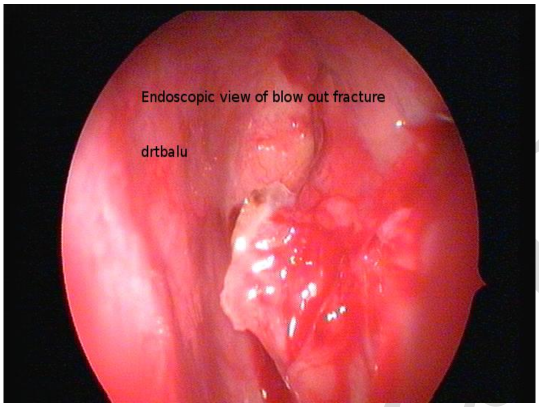



**Figure showing endoscopic view of blow out fracture orbit**

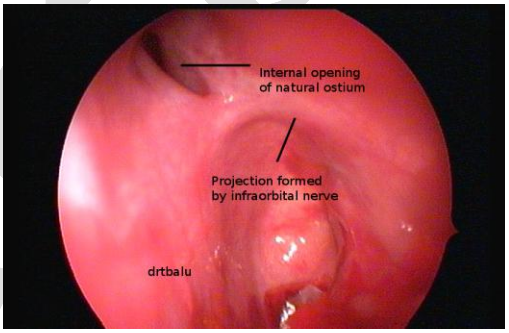



**Figure showing the interior of maxillary sinus as viewed from canine fossa approach**

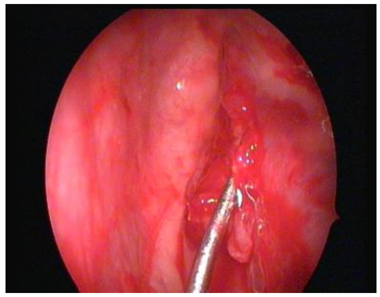


**Image showing blow out fracture being reduced**